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Denollet, J.; Tekle, F.B.; Pedersen, S.S.; van der Voort, P.H.J.; Alings, M.; van den Broek, K.C.

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Prognostic importance of distressed (Type D) personality and shocks in patients with an implantable cardioverter defibrillator

Johan Denollet [a,*], Fetene B. Tekle [b], Susanne S. Pedersen [a], Pepijn H. van der Voort [c], Marco Alings [d], Krista C. van den Broek [a]

[a] CoRPS—Center of Research on Psychology in Somatic diseases, Tilburg University, Tilburg, The Netherlands
[b] Department of Methodology and Statistics, Tilburg University, Tilburg, The Netherlands
[c] Department of Cardiology, Catharina Hospital, Eindhoven, The Netherlands
[d] Department of Cardiology, Amphia Hospital, Breda, The Netherlands

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ABSTRACT

Background: Clinical trials have shown the benefit of implantable cardioverter defibrillator (ICD) treatment. In this study, we examined the importance of chronic psychological distress and device shocks among ICD patients seen in clinical practice.

Methods: This prospective follow-up study included 589 patients with an ICD (mean age = 62.6 ± 10.1 years; 81% men). At baseline, vulnerability for chronic psychological distress was measured by the 14-item Type D (distressed) personality scale. Cox regression models of all-cause and cardiac death were used to examine the importance of risk markers.

Results: After a median follow-up of 3.2 years, 94 patients (16%) had died (67 cardiac death), 61 patients (10%) had experienced an appropriate shock and 28 (5%) an inappropriate shock. Inappropriate shocks were not associated with all-cause ($p = 0.52$) or cardiac ($p = 0.99$) death. However, appropriate shocks (HR = 2.60, 95% CI 1.47–5.58, $p = 0.001$) and Type D personality (HR = 1.85, 95% CI 1.12–3.05, $p = 0.015$) were independent predictors of all-cause mortality, adjusting for age, sex, left ventricular ejection fraction, cardiac resynchronization therapy (CRT), secondary indication, history of coronary artery disease, medication and diabetes. Type D personality and appropriate shocks also independently predicted an increased risk of cardiac death. Other independent predictors of poor prognosis were older age, treatment with CRT and diabetes.

Conclusion: Vulnerability to chronic psychological distress, as defined by the Type D construct, had incremental prognostic value above and beyond clinical characteristics and ICD shocks. Physicians should be aware of chronic psychological distress and device shocks as markers of an increased mortality risk in ICD patients seen in daily clinical practice.

1. Introduction

The Multicenter Automatic Defibrillator Implantation Trial II (MADIT-II) [1] and Sudden Cardiac Death in Heart Failure Trial (SCD-HeFT) [2] showed that implantable cardioverter defibrillator (ICD) treatment improves survival in patients who are at risk for ventricular arrhythmias [3]. The combination with cardiac resynchronization therapy (CRT-D) may further improve the clinical course of heart failure [4–6]. However, in addition to these clinical trials, research needs to further examine the outcome of ICD treatment in the real world of clinical practice [3].

Secondary analyses of MADIT-II, SCD-HeFT and the Defibrillation in Acute Myocardial Infarction Trial (DINAMIT) have shown that ICD shocks are associated with poor survival [7–9]. Advanced heart failure and comorbid conditions may attenuate the survival benefits of ICD treatment in some patients [10–12]. Psychological distress may also affect the cardiovascular system through several pathways [13–16], especially through an important involvement of the autonomic nervous system [17–19] and the induction of increased QT dispersion [18,19], increased T-wave alternans [20,21] and arrhythmia [21–24]. Both ICD shocks [25] and Type D (distressed) personality [26] have been related to distress. Type D is a propensity to chronic psychological distress that has been shown to predict adverse events in cardiac patients [27–29].

It has been argued that more research is needed on risk stratification among ICD patients seen in clinical practice [3,9]. Therefore, we wanted to examine the importance of shocks and Type D personality as risk markers of mortality following ICD treatment in the real world.

* Corresponding author at: Department of Medical Psychology and Neuropsychology, Tilburg University, PO Box 90153, 5000 LE Tilburg, The Netherlands. Tel.: +31 13 466 2175; fax: +31 13 466 2067.
E-mail address: Denollet@uvt.nl (J. Denollet).

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2. Methods

2.1. Patient sample

Patients in the study had their first ICD implanted between May 2003 and February 2009 in 2 Dutch referral hospitals (Amphia Hospital, Breda, and Catharina Hospital, Eindhoven). Patients completed a psychological questionnaire at the time of implantation (between 1 day to 3 weeks after implantation). Patients who did not return the questionnaire within 1 week received a reminder telephone call and a letter including the questionnaire. Questionnaires were returned in a stamped, pre-addressed envelope and were checked for completeness. Inclusion criteria were age between 18 and 80 years and sufficient knowledge of Dutch; exclusion criteria were cognitive impairment (e.g. dementia) and psychiatric disorders except for affective disorders. From the 645 patients that were enrolled in the study, 56 had missing data on left ventricular ejection fraction (LVEF) or shocks during follow-up or survival status. Hence, 589 patients (91%) were included in the current analyses. The study was approved by the Medical Ethics Committees of both participating hospitals, was conducted in accordance with the Helsinki Declaration, and all patients provided written informed consent. The authors of this manuscript have certified that they comply with the Principles of Ethical Publishing in the International Journal of Cardiology.

2.2. Shocks during follow-up

Shocks were considered to be appropriate if they were triggered by ventricular tachycardia or ventricular fibrillation [7] and inappropriate if they were triggered by nonventricular arrhythmias or abnormal sensing [8]. Device interrogation was used to obtain information on the nature of shocks as judged by electrophysiologists.

2.3. Type D (distressed) personality

Type D personality refers to an increased vulnerability for psychological distress that predicts poor cardiovascular outcomes [27]. All patients completed the 14-item Type D Scale (DS14) [28] at the time of implantation. The DS14 consists of two 7-item subscales, negative affectivity (e.g. "*I often feel unhappy*") and social inhibition (e.g. "*I am a 'closed' person*"). Items are scored on a 5-point Likert scale (subscale scores from 0 to 28). Patients scoring high on both subscales, according to a standardized cut-off score ≥ 10, are classified as having a Type D personality. The DS14 is a reliable scale, with Cronbach's alpha values of 0.88/0.86 and test–retest reliability over a 3-month period between r = 0.72 and 0.82 [28].

2.4. End points

The end points were all-cause death and death from cardiac causes. Medical records were checked to see whether the patient had a cardiologic check-up after January 1, 2009. Patients who had a cardiologic check-up after this date were considered alive and their follow-up date in the study was set as the most recent date they had a check-up. For patients who did not have a check-up after January 1, 2009 or who died, vital status or cause of death were discussed with the treating cardiologist and/or general practitioner.

2.5. Cardiac and non-cardiac covariates

In order to examine the incremental value of shocks and distress as predictors of mortality, a number of covariates were included as potential confounders in the multivariable models. Cardiac covariates were obtained from the medical records at baseline, and included left ventricular dysfunction (i.e., LVEF > 35% versus LVEF ≤ 35%), CRT (no/yes), ICD indication (primary prevention versus secondary prevention), coronary artery disease (CAD; no/yes), beta-blockers, and ACE-inhibitors. Non-cardiac covariates included diabetes mellitus (as reported in medical records), smoking status at baseline (no/yes), and the demographics gender and marital status (having a partner versus having no partner).

Table 1
Covariates in the total study population, and stratified by survival status.

Characteristics	Total sample N = 589	Stratified by survival status		*P* value
		Survivors N = 495	Non-survivors N = 94	
Cardiac covariates				
CRT	30% (175)	27% (133)	45% (42)	**0.001**
LVEF ≤ 35%	83% (487)	81% (402)	90% (85)	**0.030**
Secondary indication	36% (210)	36% (176)	36% (34)	0.91
CAD	73% (428)	71% (353)	80% (75)	0.091
Beta-blockers	82% (481)	83% (411)	74% (70)	**0.049**
ACE-inhibitors	68% (400)	69% (340)	64% (60)	0.36
Non-cardiac covariates				
Diabetes	19% (111)	17% (86)	27% (25)	**0.036**
Smoking	18% (106)	18% (89)	18% (17)	0.98
Male gender	81% (476)	80% (396)	85% (80)	0.25
No partner	13% (78)	14% (67)	12% (11)	0.63

CAD = coronary artery disease; CRT = cardiac resynchronization therapy; LVEF = left ventricular ejection fraction; SD = standard deviation.
Bold values indicate significance at p < 0.05.

2.6. Statistical analyses

Chi-square tests were also used to determine potential differences in cardiac and non-cardiac covariates stratified by survival status. A series of Cox regression analyses were performed to determine the univariate predictive value of age, appropriate and inappropriate shocks, Type D personality, and the cardiac and non-cardiac covariates in relation to all-cause and cardiac-related mortality. Multivariable Cox regression analyses were performed to determine the independent predictors for all-cause and cardiac-related death. All tests were two-tailed and a *p*-value < 0.05 was used to indicate statistical significance. All analyses were performed in PASW Statistics 17 for Windows.

3. Results

The mean age of the current cohort of ICD patients seen in clinical practice was 62.6 years (SD = 10.1 years); 476 (81%) were men and the majority of patients had a partner (87%). The median follow-up period was 3.2 years (range 0.8 to 6.5 years). During this period, 94 patients (16%) had died, with 67 (11%) due to a cardiac cause. There were 61 patients (10%) who experienced an appropriate shock and

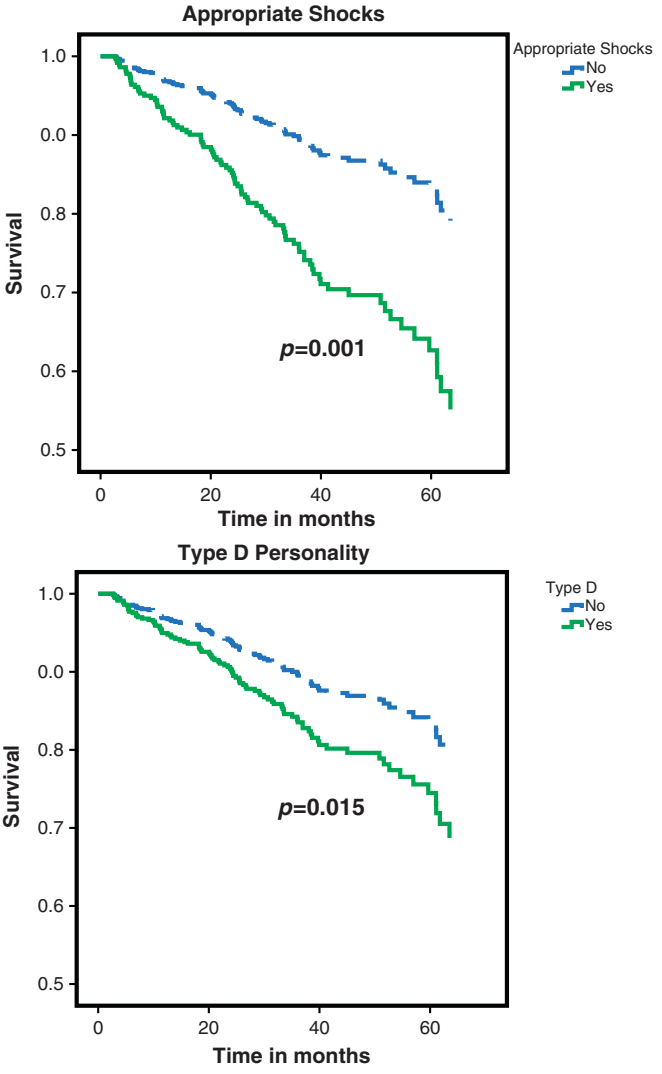

Fig. 1. Survival of ICD patients over time (N = 589), stratified by appropriate shocks (top) and Type D personality (bottom). All-cause death (N = 94) coded as 1. Multivariable analyses, adjusted for age, cardiac covariates and non-cardiac covariates.

28 patients (5%) who experienced an inappropriate shock during follow-up.

3.1. Covariates and mortality

Most patients in this cohort study had a LVEF≤35%, a history of CAD, and received beta-blocker treatment (Table 1, total sample). ICD patents that died during follow-up were significantly more likely to have a LVEF≤35%, and were more likely to be treated with CRT (Table 1). Treatment with beta-blocker was associated with improved survival rates, and a comorbid diagnosis of diabetes mellitus was also more prevalent among non-survivors.

3.2. Shocks and Type D as predictors of all-cause mortality

At inclusion in the study, 134 (23%) of the patients were diagnosed with a Type D personality. There were no significant differences between Type D and non-Type D individuals in LVEF ($p=0.57$), CRT ($p=0.30$), secondary indication ($p=0.80$) or other baseline characteristics. Survival curves showed that both appropriate shocks (Fig. 1, top) and Type D personality (Fig. 1, bottom) were significantly associated with an increased risk for all-cause mortality. A multivariable Cox regression model showed that both appropriate shocks (HR=2.60), and Type D personality (HR=1.85) were independently associated with an increased risk of all-cause mortality, adjusting for both cardiac and non-cardiac covariates (Fig. 2). Additional inclusion of inappropriate shocks in the Cox model (data not shown) indicated that these shocks were not associated with all-cause death (HR=0.72, 95% CI 0.26–1.98, $p=0.52$). Age, CRT and diabetes were the only covariates that independently predicted all-cause mortality.

3.3. Shocks and Type D as predictors of cardiac mortality

After adjustment for cardiac and non-cardiac covariates, Type D personality (HR=1.85) and appropriate shocks (HR=2.26) were also retained as independent predictors of cardiac death in the final Cox regression model (Table 2). Inappropriate shocks were not associated with cardiac death (HR=0.99) in this Cox model. CRT and age also independently predicted cardiac death (Table 2), and there was a trend for beta-blockers and diabetes ($p=.069$).

Table 2
Independent predictors of cardiac death in ICD patients.[a]

	HR	(95% CI)	*P* value
Predictor variables			
Type D personality	**1.85**	(1.03–3.32)	**0.039**
Appropriate shocks	**2.26**	(1.13–4.52)	**0.021**
Inappropriate shocks	0.99	(0.36–2.80)	0.99
Cardiac covariates			
CRT	**2.37**	(1.29–3.88)	**0.004**
LVEF≤35%	1.50	(0.60–3.75)	0.39
Secondary indication	1.08	(0.60–1.92)	0.80
CAD	1.06	(0.57–1.95)	0.86
Beta-blockers	0.60	(0.35–1.04)	0.069
ACE-inhibitors	0.80	(0.48–1.37)	0.39
Non-cardiac covariates			
Age (years)	**1.06**	(1.02–1.12)	**0.001**
Diabetes	1.70	(0.96–3.03)	0.069
Smoking	1.30	(0.69–2.46)	0.42
Male gender	1.10	(0.56–2.17)	0.78
No partner	0.70	(0.32–1.51)	0.36

CAD=coronary artery disease; CI=confidence interval; CRT=cardiac resynchronization therapy; HR=hazard ratio; LVEF=left ventricular ejection fraction.
Bold values indicate significance at $p<0.05$.
[a] Multivariable Cox regression analysis.

4. Discussion

Older age, appropriate shocks and Type D personality were independently associated with an increased risk of all-cause and cardiac death. The adverse effects of age and shocks in this clinical cohort of ICD patients are consistent with reports from clinical ICD trials [7–11]. The prognostic importance of Type D personality indicates that psychological distress should also be considered as a potential risk marker for poor survival in this patient population. Previously, Type D personality has been related to an increased risk of emotional distress [26] and ventricular arrhythmias [29] in ICD patients. The

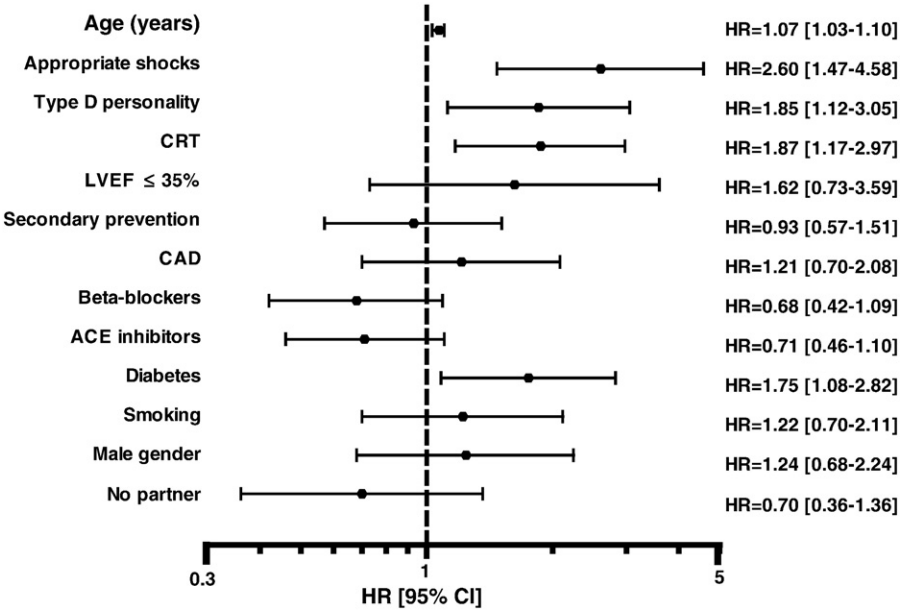

Fig. 2. Independent predictors of all-cause mortality in ICD patients (N=589). Model estimates are presented as HRs with 95% CIs. Values were calculated with the use of multivariable Cox regression analysis. CAD=coronary artery disease; CI=confidence interval; CRT=cardiac resynchronization therapy; HR=hazard ratio; LVEF=left ventricular ejection fraction.

present study showed that Type D personality also predicts an increased long-term mortality risk, independent of ICD shocks.

Increasing age, treatment with CRT, and comorbid diabetes were also associated with an increased mortality risk. This is consistent with previous reports that age-related biological changes [30,31], advanced heart failure and comorbid conditions [10–12] have an adverse effect on cardiovascular outcomes. In this population of ICD patients seen in clinical practice, shocks and Type D were both associated with all-cause and cardiac death. Psychological distress induces increased QT dispersion [18,19], T-wave alternans [20,21] and ventricular arrhythmia [21–24,29], which result in an increased mortality risk. Type D personality has also been related to a number of these mechanisms [27], but more research is needed to determine the underlying pathways by which Type D is related to an increased risk of poor prognosis in ICD patients.

Interventions such as cognitive–behavioral therapy, stress management training and assertiveness training may be useful to improve health-related behaviors and interpersonal functioning in Type D patients, and to reduce their level of emotional distress [32]. Evidence also suggests that behavioral intervention and exercise training may enhance psychosocial functioning and reduce anxiety levels in patients with an ICD [25,33]. Hence, future studies are warranted to examine the degree to which these and other interventions are effective in improving cardiovascular outcomes, including survival, in ICD patients with a Type D profile.

The findings of this study should be interpreted with some caution. Information on NYHA class was incomplete and therefore not included in the analyses. We also had no data on pro brain-natriuretic-peptide or on changes in LVEF or QRS duration that may have occurred during follow-up. Diabetes did emerge as an independent predictor of all-cause mortality, but other co-morbid conditions that were not included may also affect survival, particularly in older ICD patients. Strengths of this study are the real-world approach to examine risk stratification following ICD treatment in clinical practice [3,12], the standardized assessment of Type D personality as a potential risk marker in ICD patients [34], the prospective study design, and the use of all-cause mortality and cardiac death as clinical end-points.

A report from the National Heart, Lung, and Blood Institute and the Heart Rhythm Society recommended the development of novel risk stratification strategies to improve outcomes in ICD patients [35]. This prospective study confirms the prognostic role of ICD shocks, and suggests that chronic psychological distress has incremental prognostic value on par with the value of shocks and CRT. Cross-cultural analysis of the Type D model in 6222 cardiac patients from 21 countries around the world supports the global validity of the DS14 personality scale as a measure of chronic psychological distress [36], including patients from Eastern cultures [37]. Overall, the findings of the present study indicate that physicians should be aware of Type D personality and device shocks as independent markers of an increased all-cause and cardiac mortality risk in ICD patients seen in daily clinical practice.

5. Conflicts of interest statement

There are no relationships with industry that need to be disclosed for Dr. Denollet or Dr. Tekle. Dr. Pedersen has received consultancy and speaker's fees from St. Jude Medical, Sanofi-Aventis, Medtronic and Cameron Health, and is currently serving as a consultant for Cameron Health. Dr. Van der Voort has received speaker's fee from Medtronic. Dr. Alings reports that the Department of Clinical Electrophysiology of the Amphia Hospital has received unrestricted educational grants from Boston Scientific Netherlands, Medtronic Netherlands, and St. Jude Medical Netherlands. Dr. Alings has received consultation and speakers fees from Bayer, Boehringer Ingelheim, MSD, and Sanofi-Aventis. Dr. Van den Broek has received speaker's fee from the Sorin Group.

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